

COMPARISON OF PLANETARY EVOLUTION PROCESSES STUDYING COSMIC THIN SECTION SETS OF NASA AND NIPR. Sz. Bérczi¹, T. Földi², I. Kubovics¹, B. Lukács³ and I. Varga⁴, ¹ Eötvös University, Dept. Petrology and Geochemistry, H-1088 Budapest, Múzeum krt 4/a, Hungary (bercziszani@ludens.elte.hu), ² GEMINILUX, H-1117 Budapest, Irinyi u. 36/b, Hungary, ³ Central Research Inst. for Physics RMKI, H-1525 Budapest, P.O.Box 49, Hungary, ⁴ VARIHOLD, H-1013 Budapest, Roham u. 5, Hungary, (varihold@odin.net.hu).

ABSTRACT

Thin sections of samples from the Moon and from Antarctic meteorites represent a huge „raw material” for education in studying thermal evolutionary (inner) and metamorphic (mainly impact, outer) processes on planetary and asteroidal bodies with different sizes. This size range embraces source bodies from the parent bodies of meteorites till the Moon and Mars. Characteristics of both inner processes (equilibration, diffusion, grain-size distribution changes, melting and differentiation, etc.) and outer processes (impact effects in breccia formation) are left on the texture of fragments from these bodies. In our report we summarize almost 2 years of comparison studies on thin section sets of NASA lunar samples and NIPR Antarctic meteorites, remembering with thanks to the institutes (NASA JSC Houston, and NIPR Tokyo) which loaned the collections to the Eötvös University, Dept. Petrology and Geochemistry.

METHOD, STYLE OF REFERENCE

We used polarizational petrographic microscopes for textural studies. The samples of the two collections will be cited here as follows: NASA Lunar Sample Set consists of 12 thin sections, and NIPR Antarctic Meteorite Set consists of 30 thin sections; lunar samples get series number according to the book of C. Meyer (1), meteorite samples get number according to the inventory attached. List of samples will be given in the Appendix.

The series of phenomena to be observed will be arranged according to two systematics. First one shows the degree of thermal evolution of the known or hypothetical parent body, second will be some of the specialities, which can be found on that sample.

SEQUENCE OF SAMPLES ACCORDING TO THE THERMAL HISTORY OF THE PARENT BODY

Carbonaceous Chondrites - There are four of them: C1 - NIPR 27, CM2 - NIPR 28, CO3 - NIPR 29, CV3 - NIPR 30.

Unequilibrated Chondrites - There are four of them: EH3 - NIPR 14, H3 - NIPR 15, L3 - NIPR 19, LL3 - NIPR 23.

Equilibrated Chondrites - There are nine of them: H4 - NIPR 16, H5 - NIPR 17, H6 - NIPR 18, L4 - NIPR 20, H5 - NIPR 21, H6 - NIPR 22, LL4 - NIPR 24, LL5 - NIPR 25, LL6 - NIPR 26.

Primitive Achondrites - There is one: PA - NIPR 13.

Basalts - Achondritic - There are six of them: Aubrite - NIPR 3, Diogenite A - NIPR 5, Diogenite B - NIPR 6, Howardite - NIPR 7, Eucrite A - NIPR 8, Eucrite B - NIPR 9.

Basalts - Lunar - There are three of them: 12002 - NASA 1, 12005 - NASA 2, 70017 - NASA 3.

Basaltic Spherules - Lunar - There is one: 74220 (Orange Soil) - NASA 4.

Basalts - Martian - There is one: Shergottite - NIPR 10.

Gabbroic (Lunar Terra) Rocks - There are three of them: 60025 Anorthosite - NASA 5, 78235 Norite - NASA 6, Lunar B Norite - NIPR 12.

Ultramafic Rocks - There is one: Ureilite - NIPR 4.

Stony-irons - There are two of them: Palasite - NIPR 1, Mesosiderite - NIPR 2.

Breccias - There are three of them: 14305 - NASA 7, 65015 - NASA 8, 72275 - NASA 9.

Regolith breccias - There are two of them: 15229 - NASA 12, Lunar A - NIPR 11.

Lunar Soil Samples - There are two of them: 68501 - NASA 10, 70181 - NASA 11.

DIFFUSION

This phenomenon is most easily observable on ureilites, where diffusion of carbon give dark margins to the large grains of the granular ultramafic texture. It is also the visible effect of diffusion, that in the dark carbonaceous margins tiny metal grains of iron appears as a result of reduction of FeO in silicates by carbon.

Other, less visible phenomenon is the fading and obscuring, then disappearing of chondrules. Comparison of the H3-H6, L3-L6 and LL3-LL6 sequences is a given possibility to perceive this gradual transformation in the chondritic texture.

GRAVITATION: IMPACT SHOCKS AND FRAGMENTATION

Gravitation is effective in many processes, but direct consequences of its role can be seen in two phenomena: in diaplectic glass of impacts and frequent fragmentation on a larger body. Both the rock sample from the surface of the Moon NASA 6 (Norite) and the two planetary meteorites of NIPR 10 (Shergottite) and NIPR 12 (Norite) exhibits maskelynite. The last two samples also witness that large pressure releasing impact can liberate fragments from the planetary bodies.

Comparison of fragmented texture of asteroidal braccias (brecciated achondrites of NIPR 6, NIPR 7 and NIPR 9) with lunar surface breccias (NASA 7, NASA 8 and NASA 9) and with regolith breccias (NASA 12 and NIPR 11) we can observe that more generation of impact fragmentation resulted in wider range of grain size distribution on the larger body.

GRAVITATION: DIFFERENTIATION OF MELTS

There are two other effects of gravitation, which can be seen on thin section textures. Basalts of asteroidal sized bodies (i.e. those of achondrites, NIPR 6 and NIPR 8) exhibit more mosaic-like almost equigranular - even if recrystallized - texture, while basalts from larger bodies with great gravitation allows effects of Archimedean setting and floating, like accumulation of olivines observable on many shergottites (NIPR 10) and resulting in zoning and complex embedding

structures of the texture in the lunar samples (NASA 2 and NASA 3).

There is another effect of gravitation, but can be seen only by comparison of samples of chondrites in a sequence of increasing petrologic class. From petrologic class 4 till 6 and mainly till 7 iron grain size distribution changes. Some cases percolation of iron grains are observable, but real great step in percolation is, if we connect last stage chondrites (7 petrologic class) with mesosiderites, and/or achondrites. Both stages show accumulation of iron, on one side, or loss of iron, on the other side. This sequence shows, although indirectly, the effect of gravitation in separation of phases, at the final stages of Chondrite parent body evolution.

SECTOR ZONED PYROXENES

Of the 20 copies of the NASA Lunar Thin Section Set the Apollo 17 basalt sample No. 70017 (NASA 3) extraordinarily rich in sector zoned pyroxenes: it contains 8 of them. Sector zoned pyroxenes were recognized as early as the studies of first lunar samples of the Apollo 11 expedition. (2, 3) Even last year there was recognition of sector zoned pyroxenes in the new Martian meteorite, the QUE 94201 shergottite. (4) (In education, the aesthetical role of such remarkable phenomena is worth to mention.)

SPHERULES

New perspective of the two cosmic material collections that their samples can be used to studies of cosmic spherules. There are two types of them: lunar spherules (both volcanic and impact) and chondrules. For long time large feldspathic spherules of the Apollo 14 Fra Mauro samples were considered to have chondritic origin. Spherules with volcanic lava-fountain origin are represented by the NASA 4 thin section-sample, with orange glass spherules.

SUMMARY

The NASA and NIPR cosmic material thin section sets are useful tools not only for education but for the synthetic view of phenomena, which can not be connected only one single sample. Both our calculations and modelling of thermal history of chondrite parent bodies and cosmopetrographic comparisons of yet not understood phenomena (spherules) has got ideas from the work on them. Thanks for institutes which loaned them.

REFERENCES

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APPENDIX

The number of the samples in the two cosmic material thin section sets:

NASA Lunar samples:

1 - 12002, 2 - 12005, 3 - 70017, 4 - 74220, 5 - 60025, 6 - 78235, 7 - 14305, 8 - 65015, 9 - 72275, 10 - 68501, 11 - 70181, 12 - 15229.

NIPR Antarctic Meteorites:

1 - Y 8451, 2 - ALHA 77219, 3 - ALHA 78113, 4 - ALHA 77257, 5 - Y 74097, 6 - ALHA 77256, 7 - Y 7308, 8 - Y 791195, 9 - Y 74450, 10 - ALHA 77005, 11 - Y 86032, 12 - Asuka 881757, 13 - Y 794046, 14 - Y 691, 15 - Y 791428, 16 - ALHA 77233, 17 - Y 74079, 18 - Y 74014, 19 - Y 74191, 20 - Y 74355, 21 - Y 790957, 22 - ALHA 769, 23 - Y 790448, 24 - Y 74442, 25 - ALHA 78109, 26 - Y 75258, 27 - Y 82162, 28 - Y 74662, 29 - Y 791717, 30 - Y 86751.